GENERAL LIBRARY,
UNIV. OF MICH.
OCT 1897

Compressed Air

DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. II. NEW YORK, OCTOBER, 1897. No. 8

VIEW OF PNEUMATIC INTERLOCKING TOWER AT WEST END OF UNION PASSENGER STATION OF NASHVILLE, CHATTANOOGA & ST. LOUIS RAILWAY, NASHVILLE, TENN.
THE MACHINE IN TOWER HAS 44 LEVERS, 4 OF WHICH ARE SPARE. THERE ARE HANDLED FROM THIS TOWER 16 SWITCHES, 24 SIGNALS AND 3 DERAILS.

LIDGERWOOD M'F'G CO.,

Boston.
Philadelphia.
Cleveland, O.

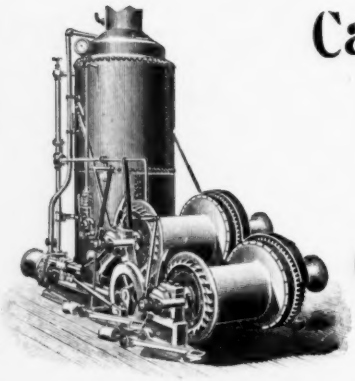
96 Liberty Street,
New York.

Chicago.
Portland, Ore.
New Orleans.

STANDARD

High . . .
Speed
Hoisting Engines,

Built on the Duplicate Part System.



Cableways,
Hoisting
and
Conveying
Devices,

For Canal and Trench Excavating, Dam Construction, Wall and Pier Building, Mining, Quarrying, Logging, and General Contract Work.

Fiske Brothers Refining Co.

NON-CARBONIZING OIL

FOR USE IN AIR CYLINDERS OF

AIR COMPRESSORS

Also All Grades of Lubricants for Use on Machinery

Propelled by Compressed Air

OFFICE AND SALESROOM, 59 WATER STREET,

CABLE ADDRESS,
"LUBROLEINE."

NEW YORK, U. S. A.

McNAB & HARLIN M'F'G CO.,

MANUFACTURERS OF

BRASS COCKS,

PLUMBERS' BRASS WORK,

Globe Valves, Gauge Cocks, Steam Whistles and Water Gauges,

WROUGHT IRON PIPE AND FITTINGS,

Plumbers' and Gas Fitters' Tools,

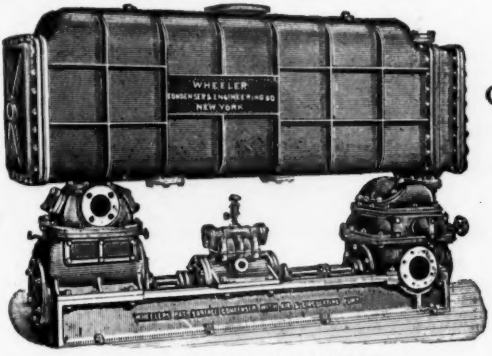
No. 56 JOHN STREET, - - NEW YORK.

Factory, Paterson, N. J.

Wheeler Condenser & Engineering Co.

120 & 122 LIBERTY STREET, NEW YORK.

For MARINE and STATIONARY SERVICE.

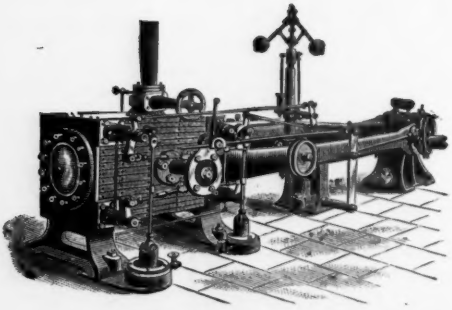


SURFACE CONDENSERS Mounted on Combined Air and Circulating Pumps.

PROPRIETORS AND MANUFACTURERS OF

WHEELER STANDARD SURFACE CONDENSER; WHEELER ADMIRALTY SURFACE CONDENSER; WHEELER LIGHTHALL SURFACE CONDENSER; VOLZ PATENT SURFACE CONDENSER AND FEED WATER HEATER; EDMISTON PATENT FEED WATER FILTER.

WHEELER'S PATENT FEED WATER HEATER.



Established
1833.

The
C. & G. COOPER CO.

MT. VERNON, OHIO.

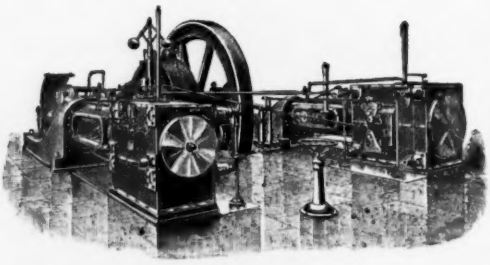
CORLISS ENGINES.

COMPOUND.

TRIPLE EXPANSION.

SINGLE CYLINDER.

Of all sizes up to 3,000 Horse-power.



— FOR —

FACTORIES, RAILWAYS, ELECTRIC LIGHTING, ROLLING MILLS, AND ALL KINDS OF MANUFACTURING.

CORRESPONDENCE SOLICITED.

HOME OFFICE: MT. VERNON, OHIO.

NEW YORK: Room 1022 Havemeyer Building, F. W. IREDELL, Mgr.

MANCHESTER, N. H., Aug. 21, 1897.

COMPRESSED AIR.

GENTLEMEN: With this I enclose order and one dollar P. O. order for my subscription to COMPRESSED AIR. I think much of this publication.

Yours truly, A. G. STEVENS.

Would you like to make some extra money?

We will give a very liberal commission to any one who can make up a club of ten subscribers.

Write for terms,

COMPRESSED AIR,
26 Cortlandt Street, N. Y.

G. WILFRED PEARCE,
Electrical, Steam and Compressed Air Apparatus,
ST. PAUL BUILDING, NEW YORK.

Trimo Pipe Cutter.

Made in three sizes to cut pipe from ⅛ to 3 inches.

SEND FOR OUR CATALOGUE OF TRIMO TOOLS.

TRIMONT MFG. COMPANY, ROXBURY, MASS.

Empire Engine & Motor Co.,

26 CORTLANDT ST., NEW YORK.

Reamers that Wont get Stuck or Break Down.

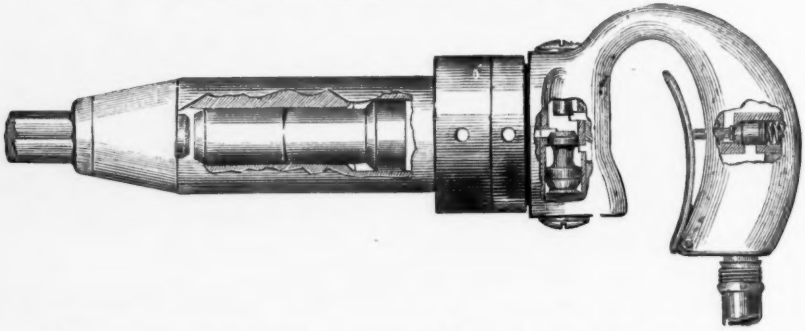
DRILLING AND TAPPING MACHINES THAT REVERSE.

Hoists that Will Hold a Load, Without Depending on the Air . . . . . Pressure. . . . . .

MACHINES SENT ON TEN DAYS TRIAL.

United States Metallic Packing Co.,

PHILADELPHIA, PA.



Manufacturers of the most economical Air Tools in the market, such as

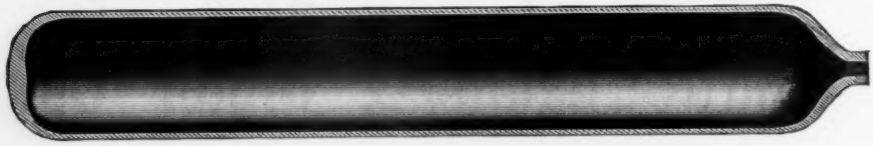
PNEUMATIC HAMMERS,
" DRILLS,
" TRACK SANDERS,
" BELL RINGERS.

METALLIC PACKING FOR ALL KINDS OF SERVICE.

CHICAGO OFFICE:
1003 MARQUETTE BUILDING.

OFFICE AND WORKS:
427 NORTH 13th STREET.

MANNESMANN TUBE WORKS,



MANUFACTURERS OF

Seamless Rolled Tubes for Gases, Compressed Air, Etc.,

UNDER HIGH PRESSURE.

Tested and approved by the highest authorities and Governments of Europe and America.

Each Tube is carefully tested, and a Government Test Certificate is furnished with each Tube. Representatives:—

CHAS. G. ECKSTEIN & CO.,

45 VESEY STREET, - - - NEW YORK.

J. D. MILLER & CO.,

TAYLOR BUILDING, 39 & 41 CORTLANDT ST., N. Y.

COMPLETE POWER PLANTS,

FOR ALL PURPOSES

ENGINES, BOILERS, MACHINERY,

MINING AND MILLING EQUIPMENTS.

Send for Catalogues and Estimates on what you need.

The FOSTER

New "Class W"
(Automatic)
Pressure
Regulator.

The only Pressure Regulator satisfactorily controlling High Initial Air Pressures.

In successful service on ALL the AIR-MOTORS yet tested.

FOSTER ENGINEERING CO.,

NEWARK, N. J.

PNEUMATIC APPLIANCES.

DRILLS, REAMERS, TAPPERS,
RIVETERS, CAULKERS, CHIPPERS,
HOISTS, MOTORS, COMPRESSORS,
STAY BOLT CUTTERS, SAND SIFTERS, ETC.

SEND FOR NEW CATALOGUE JUST ISSUED.

C. H. HAESELER CO.,

1026-1030 HAMILTON STREET, - - PHILADELPHIA, PA.

THE PELTON WATER WHEEL

Embracing in it variations of construction and application

THE PELTON SYSTEM OF POWER.

In simplicity of construction, absence of wearing parts, high efficiency and facility of adaptation to varying conditions of service, the **PELTON** meets more fully all requirements than any other wheel on the market. Propositions given for the development of water powers based upon direct application, or **Electric Transmission** under any head and any requirement as to capacity.

Compressed Air Transmission.

No other wheel is so well adapted to this purpose. Where the head admits, it can be attached to compressor shaft direct, and serve for prime mover and fly wheel as well.

Correspondence Invited. Catalogues Furnished upon Application. Address,

PELTON WATER WHEEL CO.,

121-123 MAIN STREET, SAN FRANCISCO, CAL.

143 LIBERTY STREET, NEW YORK.

BOSTON. NEW YORK. PITTSBURG. CHICAGO. ST. LOUIS.

National Tube Works Company,

MANUFACTURERS OF

Standard Steam, Gas and Water Pipe.
Locomotive and Stationary Boiler Tubes.
Special Flanged Pipe for Compressed Air.
Pump Columns for Mines.
Special Light Lap-Welded Pipe, fitted with the Converse Patent Lock Joint for Water and Gas Mains.
Cylinders with Dished or Flat Heads for Carbonic Acid and other Gases.

NEW YORK OFFICE: HAVEMEYER BUILDING.

An Important Connecting Link in Compressed Air Service

The Moran Flexible Joint

For high pressure, indispensible.

Tightness, safety, flexibility and durability assured.

Parties making experiments with Compressed Air may have the use of the "Moran Joint," free for a limited time.

MORAN FLEXIBLE STEAM JOINT CO.,

LOUISVILLE, - - - - - KENTUCKY

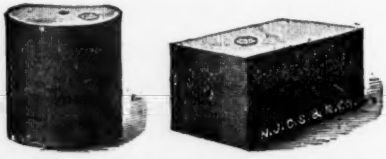
ESTABLISHED 1858.

"Our Name and Brand a Guarantee of Quality."

High Grade Rubber Goods.

CHANNELING SPRINGS.

BELTING.
TUBING.
VALVES.
HOSE
TUBING.



SPRINGS.
MATS.
MATTINGS.
GASKETS.
PLAY PIPES.

LINEN AND COTTON HOSE.

NEW JERSEY CAR SPRING & RUBBER COMPANY,

MAIN OFFICE AND WORKS:

Wayne and Brunswick Streets, Jersey City, N. J.

BRANCH OFFICE: 10 BARCLAY ST., NEW YORK.

Compressed Air.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - Editor and Publisher
A. E. KENNEY, - - Managing Editor
J. E. QUINTERO, F. C. WEBER, - - - - - Associates

Subscription, including postage, United States, Canada and Mexico $1.00 a year. All other countries, $1.50 a year. Single copies, 10 cents.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.

London Office, 114a Queen Victoria Street.

Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

VOL. II. OCTOBER, 1897. NO. 8.

In one of the early numbers of COMPRESSED AIR we called attention to the fact that a reliable air meter for measuring air volumes was in demand. We have recently been informed that Mr. Clemens Herschel, the distinguished hydraulic engineer who designed the Venturi water meter, is prepared to apply the Venturi principle to air. There seems no reason to doubt that this meter, which has established its place as the simplest reliable means of measuring large water volumes, might apply equally as well to compressed air. A great advantage of the Venturi principle is that it does not retard the flow of the liquid or gas measured. Mr. Herschel, whose address is No. 2 Wall Street, this city, will take the details of this subject up with those contemplating its introduction.

COMPRESSED AIR has not been enthusiastic in advocating the recent experiments in air traction on the New York Elevated Railroad. These experiments as far as they have been conducted, have demonstrated two points clearly. In the first place, it has been shown that air can be compressed and stored economically and safely at 2,500 pounds pressure. Never before has a compressing plant on so large a scale and of so high a class in design been applied and tested for any such service as this, nor has there ever been, to our knowledge, a case where air has been stored at 2,500 pounds pressure at so low a cost as in the generating plant used in this instance. It has also been demonstrated that this air can be used with reasonable economy in a motor which will pull a train of loaded cars between the Battery and Central Park and return. That this can be done at less expense in fuel and labor than the present system of steam locomotion, is a fact about which there will be little dispute. The locomotive is wasteful in fuel because its engine utilizes only a small portion of energy within the steam; the high pressure exhaust indicates this lack of steam economy. In the case of air produced by compound condensing Corliss engines, we have a horse-power produced at an expenditure of about 2 pounds of coal as against 6 or 8 in the locomotive. This air when used is cut off and expanded in the motor and thus its power is not wasted. But it is not a question between air and steam, but between air and electricity. Both can beat the present system, but in the present condition of pneumatic traction it does not appear to us wise to attempt a case like the Elevated Road until after pneumatic tramcars have been developed and perfected. From an engineering point of view, it would seem easier and safer to develop motors for carrying passengers in street cars first and then lead up to larger things. From the business point of view, the street car field is broader and offers greater opportunity for profit. It would also seem that this field might be cultivated and developed to a paying point at considerably less expenditure, and in a matter of this kind, which at best must be expensive in experimental work, it is wise to count the cost, lest the experiment fail through want of funds, even though its success from a mechanical standpoint is assured.

The Thomas Pneumatic System of Handling Railway Switches and Signals.

The fundamental feature of this system is the manipulation of the valves admitting air to and exhausting it from the working cylinders of railway switches and signals by means of pistons of the equalizing type, the pistons being actuated by a sudden increase or decrease of the air pressure.

SWITCHES.

Fig. 1 is axial section of valves for admitting air to and exhausting it from the working cylinders of switch, and also shows section of reservoirs 6 and 6^1.

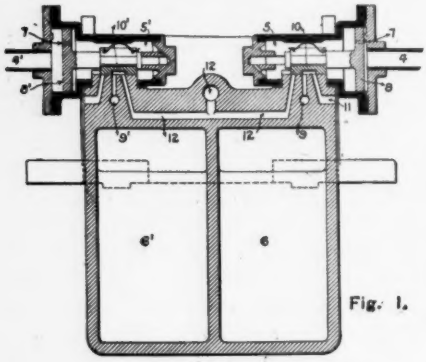


Fig. 1.

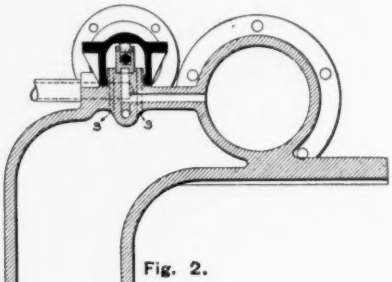


Fig. 2.

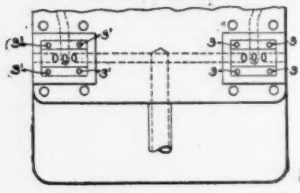


Fig. 3.

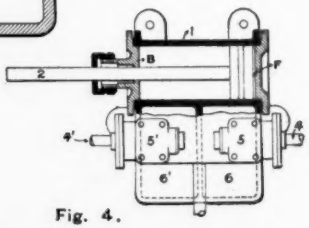


Fig. 4.

RESERVOIRS AND VALVES.

Fig. 2 is cross-section.

Fig. 3 is top view of reservoirs and valve seats.

Fig. 4 is axial view of working cylinder and top view of chests and reservoirs.

When switch is in its normal position, pressure in controlling pipe 4, chest 5 and reservoir 6, is at 70 lbs., the pressure in chest 5 and reservoir 6 having equalized with the pressure in controlling pipe 4 by means of equalizing port 7; chest 5 and reservoir 6 are in communication by means of passages 3, Fig. 3. The pressure in controlling pipe 4^1, chest 5^1, and reservoir $6,^1$ is at 80 lbs., these pressures having equalized through feed port 7^1, Fig. 1, and ports 3^1, Fig. 3. Under these conditions, piston 8 is to the right; and F end of cylinder 1, Fig. 4, is in communication with the atmosphere by way of port 9, slide valve 10, and exhaust port 11. Piston 8^1 is also to the right, and B end of cylinder 1 is in communication with main supply 12, by way of slide valve 10^1 and port 9^1. In order to reverse the switch, pressure in controlling pipe 4 must be increased, and as the increase takes place more rapidly than air can flow through equalizing port 7, piston 8 is moved to the left, taking slide valve 10 with it, thereby admitting air at 80 lbs. pressure from main supply 12 to F end of cylinder 1; at the same time pressure in controlling pipe 4^1 must be reduced, and as the reduction takes place more rapidly than air can pass through equalizing port 7^1, piston 8^1 is moved to the left, valve 10^1 is carried with it, and air is exhausted from B end of cylinder 1, and switch goes over. Reservoirs 6 and 6^1 are added to increase the capacity of chests 5 and 5^1 respectively. The minimum pressure in controlling pipes is 70 lbs., the maximum pressure 80 lbs.

To the frame of interlocking table in tower is attached a switch controlling valve 13, view of which is shown at Fig. 5. Port 4 is connected to controlling pipe 4,

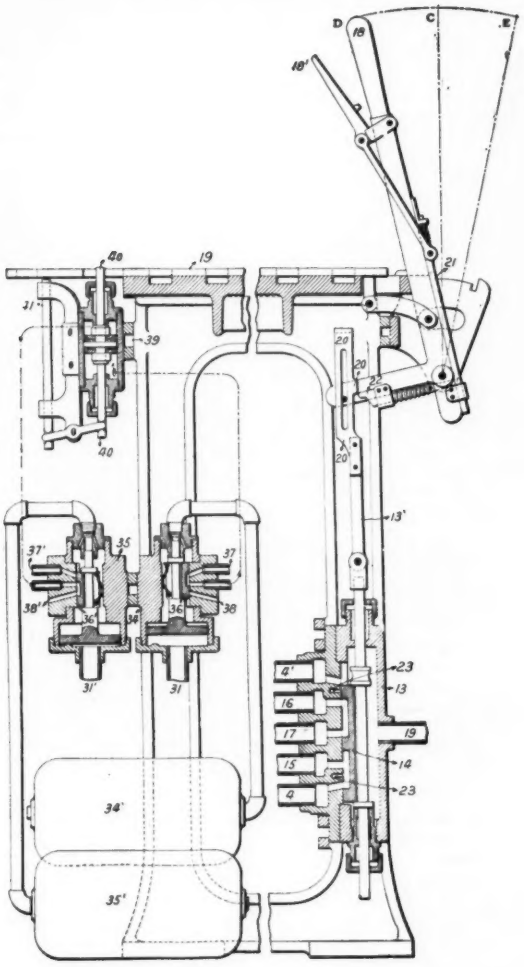


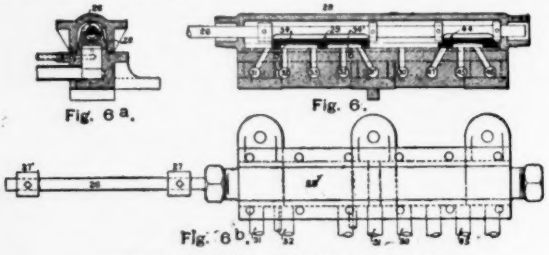
Fig. 5.

SECTION OF INTERLOCKING TABLE.

and port 4^1 to controlling pipe 4^1 of Fig. 1. Ports 15 and 16 are each connected to a cast iron reducing reservoir located at some suitable point in tower; port 17 is the exhaust. With operating lever 18 in its normal position, slide valve 14 takes the position as shown in drawing, and air from main supply 19 flows into controlling pipe 4^1. Controlling pipe 4 is in communication with reducing reservoir 15; reservoir 16 is in communication with the atmosphere by way of exhaust port 17. When it is desired to reverse the switch, valve 14 is moved upward, thereby closing communication between body of chest and controlling pipe 4^1 and reducing reservoir 16, and as all of the air has been exhausted out of reservoir 16, air from controlling pipe 4^1 flows into this reservoir, thus reducing the pressure in controlling pipe 4^1; at the same time valve 14 uncovers port 4, and pressure in controlling pipe 4 is in-

creased to 80 lbs.; reservoir 15 is also put in communication with the atmosphere, thus exhausting the air out of said reservoir. The reservoirs should be of such size as to reduce the pressure in the controlling pipes about 10 lbs. when communication is established between them.

In order to accomplish the interlocking, it must be so arranged that lever 18 and its tappet 19 must make but one-half of their stroke unless the switch has properly responded, therefore slide valve 14 must be shifted its full throw during the first half of the stroke of lever 18, said lever to have a silent movement in passing from its C to its E position, at least so far as slide valve 14 is concerned. To the upper end of valve stem 13^1 is secured piece 20. When it is desired to reverse switch, latch lever 18^1 is brought up against lever 18, thus raising latch 21 out of notch in quadrant and putting latch 22 in engagement with lower part of projection on 20. After valve 14 has traveled its full throw, it strikes against stop in chest, thus preventing lever 18 from going further than its C position; latch lever 18^1 is then released and latch 22 is disengaged from 20, after which lever may be taken to its E position, if switch responds properly. When it is desired to put the switch back to its normal position, latch 22 is brought into engagement with top of projection on 20; valve 14 is shifted to its normal position, thus reducing pressure in controlling pipe 4 and increasing pressure in controlling pipe 4^1. Valve 14 is moved its full throw by the time lever 18 reaches its C position. Latch 18^1 is now released and lever may be brought to its D or normal position, provided switch has properly responded.



SWITCH APPARATUS—INDICATION CHEST.

SWITCH INDICATION.

As it is of the utmost importance that there be no question as to whether a switch responds properly or not, two indication pipes are used, it being impossible to get the proper indication with one pipe, for at one move or the other the indication would have to be gotten by reduction of pressure, and as this reduction might be the result of a leak, a false indication would be gotten. With two indication pipes, in one of which the pressure must be reduced and the pressure in the other increased in order to give the indication and release the lever, a false indication cannot be gotten. At Figs. 6 and 7 is shown the apparatus at switch for giving indications. The switch and lock movement has 8 inches stroke, whereas the switch points have only 4 inches, therefore bar 24, Fig. 7, moves 2 inches before the points begin to move and 2 inches after the points are up. To bar 24, which is coupled direct to piston rod 2, is bolted arm 25. Through the outer end of the arm passes valve stem 26, the stem being provided with adjustable knockers 27 and 27^1. With switch in its normal position, slide valve 29, Fig. 6, takes the position shown; chest 28 is supplied with air at 80 lbs. pressure through connection 30, and as indication pipe 31, leading from switch to tower, is in communication with body of chest, it contains air at 80 lbs. pressure. Indication pipe 31^1 being in communication with reducing reservoir 32^1, contains air at 70 lbs. Port 33 is exhaust. Attached to the locking table in the tower (see Fig. 5) are two valves, 34 and 35, and tappet locking device 39. With switch in its normal position, indication pipe 31, valve 34 and reservoir 34^1 contain air at 80 lbs. pressure, and slide valve 36 has established communication between main supply and lower end of cylinder 39, forcing its piston upward. Indication pipe 31^1, valve 35 and reservoir 35^1 contain air at 70 lbs. pressure, and slide valve 36^1 has exhausted air from upper end of cylinder 39. Rod 41 is so connected to piston rod 40 that when 40 moves downward, 41 moves upward, and vice-versa.

Fig. 8 shows relative position of tappet and locking pins with tappet, lever and switch in their normal position.

Fig. 9 shows relative position of tappet and locking pins with lever and tappet in their C position, should switch fail to respond.

Fig. 10 shows relative position of tappet and locking pins in their C position, if switch responds properly and lever free to be moved to its E position.

Fig. 10-a shows relative position of tappet and locking pins with tappet, lever and switch in their reversed position. It will be noted that pin 41 is ready to stop tappet at half-stroke should switch fail to respond when lever is brought from its E to its C position.

Should lever 18 be brought from its D to its C position and switch fail to respond, it would be impossible to complete the stroke of the lever or its tappet 19, as edge 42^1 of slot 42, Figs. 8, 9, 10 and 10-a, would be brought up against piston rod or pin 40. If switch responded properly, arm 25, Fig. 7, would strike knocker 27^1, valve 29, Fig. 6, would be forced to the left, indication pipe 31 would be put in communication with reducing reservoir 32, and pressure reduced to 70 lbs.; indication pipe 31^1 would be put in communication with body of chest 28, pressure would be increased to 80 lbs., and air would be exhausted out of reservoir 32^1 through exhaust port 33. A reduction of pressure in pipe 31 would cause piston of valve 34 to move downward, and slide valve 36 would exhaust air from bottom end of cylinder 39, an increase of pressure in indication pipe 31^1 would move piston of valve 35 upward, and slide valve 36 would admit air into upper end of cylinder 39, thus lowering pin 40, Figs. 5, 8 and 9, out of engagement with notch 42 and raise pin 41 into notch 43 on opposite side of tappet 19 (see Figs. 10 and 10-a). The lever can now be put in its reversed or E position. With locking pins in position shown at Fig 10-a, pin 41 is ready to stop tappet at half-stroke should switch fail to respond when lever is brought from its E to its C position.

It might be well to add just here that, to interlock the levers of the machine, the beveled type of locking is used; hence if lever cannot be fully reversed, it locks all levers with which it is interlocked.

Reservoirs 34^1 and 35^1 are used to increase capacity of valves 34 and 35 respectively.

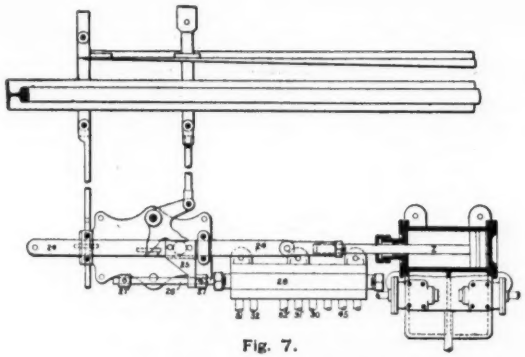


Fig. 7.

SWITCH AND LOCKING APPARATUS.

TWO-POSITION SIGNALS.

Fig. 11 is general arrangement of parts on mast.

Fig 12 is indication chest.

Fig. 13 is vertical section of signal valve and cylinder.

Fig. 14 is cross section of signal valve, cylinder and reservoir.

Fig. 15 is top view of valve seat.

With signal in its normal position, controlling pipe 1, chest 2 and reservoir 3 (see Fig. 13), contain air at 70 lbs. pressure, the equalization between controlling pipe and chest having taken place by means of equalizing port 5, and the equalization between chest 2 and reservoir 3 having taken place through ports 6, Fig. 15; piston 7 and slide valve 8 are to the left, air is exhausted out of operating cylinder 9, and counterweight 10, Fig. 11, has brought

blade to its horizontal or danger position. To put signal to safety, pressure must be increased in controlling pipe 1, and as the increase takes place more rapidly on the controlling pipe side of piston 7 than it does on the opposite side of said piston, piston is forced to the right, carrying with it slide valve 8; exhaust port 11 is closed; air from main supply 12 is admitted by way of port 13 to operating cylinder 9, and blade is brought to its vertical or safety position. Reservoir 3 is added to increase capacity of chest 2.

Signal controlling valve 16 (see Fig. 16) is bolted to frame of locking table; 1 is controlling pipe leading from tower to signal; 25 is port leading to reducing reservoir 25^1; 26 is exhaust. With valve 17 in the position shown, controlling pipe 1 is in communication with reducing reservoir 25^1, and pressure in controlling pipe is at 70 lbs. To put signal to safety, valve 17 is brought to its highest position and air at 80 lbs. pressure flows from body of signal controlling valve 16 into the controlling pipe, thus increasing the pressure, and, as heretofore explained, signal goes to safety. To restore signal to danger it is only necessary to put valve 17 in the position shown at Fig. 16, thereby establishing communication between controlling pipe 1 and reducing reservoir 25^1, air flowing into this reservoir reducing the pressure in controlling pipe; piston 7, Fig. 13, is shifted to the left, carrying its slide valve with it, thus exhausting the air out of working cylinder. and counterweight takes signal to danger.

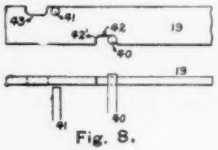


Fig. 8.

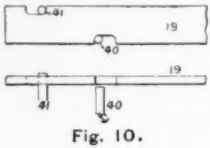


Fig. 10.

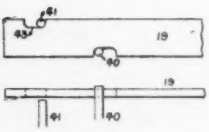


Fig. 9.

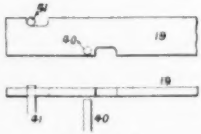


Fig. 10 a.

POSITION OF TAPPETT AND LOCKING PINS.

SIGNAL INDICATION.

Assuming that it is more important to know that a signal resumes its danger position than it is to know that it goes to safety, the indication for signals has been arranged so that an increase of pressure must take place in the indication pipe before the lever operating the signal can be brought near enough to its normal position to unlock conflicting levers.

Valve 27, Fig. 12, controls the pressure in the indication pipe 28, leading to tower; 29 is main supply; 31 is exhaust: 30 is port leading to reducing reservoir 30^1, located at foot of mast. With signal in its normal position, indication pipe 28 is in communication with main supply, hence contains air at maximum pressure. Controlling pipe 28 is connected with indication valve 32 in tower (see Fig. 16); 33 is connection to reservoir for increasing the capacity of chest 32; 34 is main supply; 35 leads to upper end of cylinder 37; 36 is exhaust.

Fig. 17 shows relative position of tappet and locking pins with tappet, lever and signal in their normal position.

Fig. 17-a shows relative position of tappet and locking pins with lever and tappet in their C position should signal fail to go from danger to safety.

Fig. 18 shows relative position of tappet and locking pins with tappet and lever in their C position and free to be moved to their E position, signal having gone from danger to safety.

Fig. 18-a shows relative position of tappet and locking pins with lever and tappet in their reversed position and signal at safety. It will be noted that pin 40 is ready to stop lever at its C position as it is being moved from E towards D if signal does not go to danger.

As heretofore stated, indication pipe 28 contains air at 80 lbs. pressure when signal

is at danger; chest 32 and reservoir 33^1 also contain air at 80 lbs. pressure. Under these conditions piston 32^1 of valve 32 is in its highest position, and air from main supply 34 is admitted into upper end of cylinder 37, forcing locking pin 40 down and locking pin 41 up. When lever 18 is brought to its C position, valve 17 has moved its full stroke; said valve is then dropped, and if signal responds properly, slide valve 27^1, Fig. 12, reduces the pressure in indication pipe 28 by establishing communication between said indication

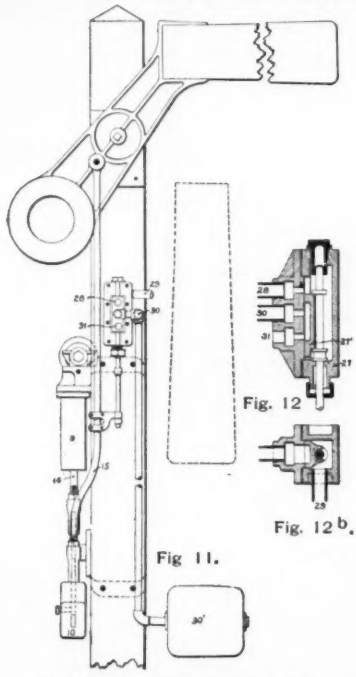


Fig. 12.

Fig. 12b.

Fig 11.

SEMAPHORE OPERATING PARTS.

pipe and reducing reservoir 30^1, Fig. 11; piston 32^1 of valve 32, Fig. 16, is actuated, air is exhausted out of upper end of cylinder 37, and spring 38 forces locking pin 41 down out of engagement with slot 43, and locking pin 40 up and into engagement with slot 42 (see Fig. 18), and lever and its tappet is now free to move to its E position. Should signal fail to respond properly, pressure in indication pipe 28 would not be reduced, air would not be exhausted out of cylinder 37, locking pin 41 would not be withdrawn from slot 43, and lever 18 could not be moved beyond its C position (see Fig. 17-a). If after lever is brought from its E to its C position, signal should fail to go to danger valve 27^1, Fig. 12, would not be shifted, pressure in indication pipe 28 would not be increased, equalizing piston 32^1 of valve 32 would not be actuated, upper end of cylinder 37 would not be charged with air, pin 40 would not be withdrawn from slot 42, Fig. 18, and lever 18 and its tappet could not be moved beyond its C position, and all conflicting levers would remain locked.

THREE-POSITION SIGNAL.

Fig. 25 is controlling valve attached to interlocking table, for handling three-position signal.

Fig. 26 is general arrangement of parts on mast.

With lever and controlling valve in their normal positions, controlling pipe 1, which leads to equalizing valve operating the signal from its danger to its caution position, and port 4, which leads to equalizing valve operating signal from its caution to its safety position are in communication with reservoirs connected to ports 2 and 5 respectively, and contain air at 70 lbs. pressure, any leaks in the pipes being supplied by ports 39 and 39^1.

To bring signal from its danger to its caution position, valves 17 and 17^1 are moved a half stroke and air at 80 lbs. pressure passes from body of chest, through port 18 in slide valve 17 to controlling pipe 1, equalizing piston on mast is actuated and signal goes to its caution position; at the same time ports 2 and 3 are put in communication and air is exhausted out of the reducing reservoir of controlling pipe 1. If it is desired to give a caution position, latch lever 18^1, Fig. 16, is released, and lever 18 is carried to its reversed position, in order to get the necessary locking. This cannot be done, however, until the proper indication is gotten, showing that the signal has reached its caution position. If it is desired to give a safety signal, latch lever 18^1 is not released, but after indication is gotten, showing that signal has reached its caution position, slide valve 17 and 17^1 are moved the remainder of their stroke, and air at 80 lbs. pressure from body of chest passes into port 4 and from thence to equalizing valve which operates the signal from its caution to its safety position; at the same time ports 5 and 6 are put in communication and air is exhausted out of reducing reservoir of controlling pipe 4 into the atmosphere through exhaust port 6.

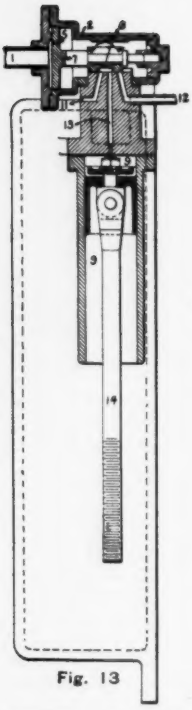


Fig. 13

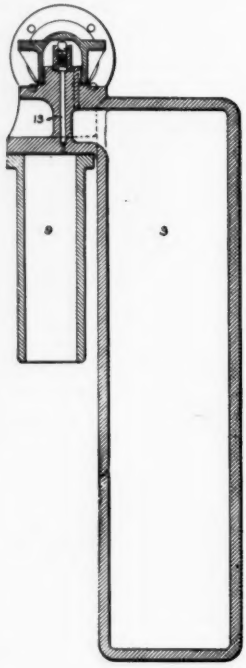


Fig 14.

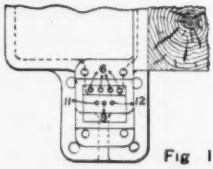


Fig 15.

SIGNAL VALVE AND CYLINDER.

The equalizing valves, reservoirs and operating cylinders on the mast are duplicates of those used for operating two-position signals, but are coupled as shown, in order that both cylinders can be used in manipulating the blade.

PNEUMATIC SELECTOR.

A pneumatic selector is provided by adding slide valve 44 to indication chest (see Fig. 6). The controlling pipe from tower runs to an equalizing valve similar to signal equalizing valve No. 2, Fig. 13, this valve being fastened by means of a bracket to valve 28, Fig. 6. Port 13 of the equalizing valve leads to port 45, Fig. 6. With switch in its normal position, main supply would pass through port 13 of equalizing valve 13; thence to port 45 of selector slide valve; thence by way of port 46 of selector slide valve to the cylinder of one signal. If switch was in its reverse position, main supply from port 13 of equalizing valve would go to cylinder of the second signal by way of ports 45 and 47 of slide valve 44, Fig. 6.

Where selectors are used, one signal equalizing valve handles two or more signals.

PNEUMATIC SLOTS.

A pneumatic slot is provided by running the controlling pipe from one tower to the back of the controlling valve of a second

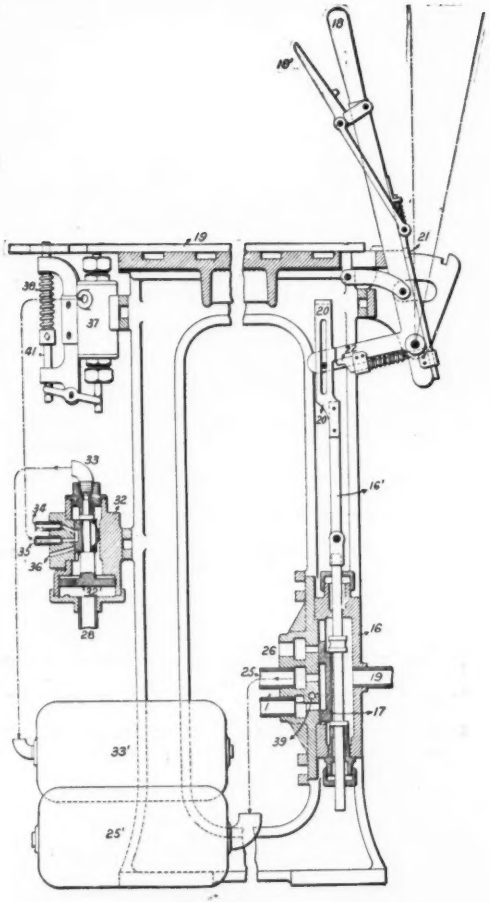


Fig. 16.

SIGNAL CONTROLLING VALVE.

tower, and introducing a check to properly control the current of air. A leak in this check does not affect the working of the slot, from the fact that a leaky check valve will not allow the increase and reduction of pressure to take place fast enough to operate the equalizing signal valve.

LOCKING DOGS.

Switches and signals must respond properly before levers operating them can be fully reversed. It is obvious that lever can be brought from its D to its C position, which, as heretofore explained, should operate the switch or signal, and that, while the switch or signal is moving, the lever can be returned to its E or D position. Take signal lever for example: When lever is brought from its D to its C position, signal should go to safety. Now, while the increase of pressure is taking place in the controlling pipe, signal is moving from danger to safety, and the decrease of pressure is taking place in indication pipe; there is nothing to prevent lever being returned to its D position, the locking pin striking the bottom of the tappet. Signal lever and its tappet would then be in their normal or danger position and the signal at safety. To obviate this it must be so arranged that after a lever

has been started from its normal or reversed position, it cannot be returned to either of these positions again until it has made full stroke backward or forward, as the case may be. To this end, pawl and ratchet arrangement shown at Fig. 24 is used.

K-L is slot in side of quadrant M; 1 is pin passing through and secured to lever; pawl N is pivoted to outer end of pin 1 and engages with ratchet Q. The lower end of pawl N is pivoted to rod P; rod P has spring P^1. Rod P engages with eye bolt, the bolt being fastened to quadrant. As lever is being carried from its D to its C position, that part of pawl marked N^1 engages with teeth in ratchet Q. If after lever is started from its normal position, any effort is made to return the lever to its normal position before it is carried to its E or reversed position, N^1 engages with the teeth and prevents the movement. When lever reaches about three-quarter stroke, pawl N strikes pin R^1, the position of pawl is reversed, and that part of pawl N'' engages with the teeth in the ratchet and will prevent lever after having been once moved from its E or reversed position, being returned to that position until it has moved to its D position.

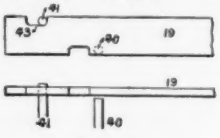


Fig. 17.

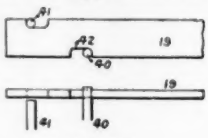


Fig. 18.

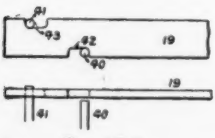


Fig. 17 a.

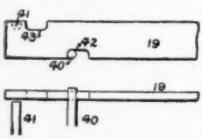


Fig. 18 a.

POSITION OF TAPPETT AND LOCKING PINS.

LEAKAGE.

As it is almost a matter of impossibility to keep the pipe lines perfectly tight, a system of feed ports have been introduced whereby the low pressure pipes are supplied with air at minimum pressure—that is, 70 lbs. As signals are kept at danger except when they are lowered to permit a train to pass, and as when signals are at danger the indication pipes are in direct communication with the main supply, and as the indication pipes are only cut off from the main supply when the signals are at caution or safety, it has not been found necessary to arrange to take care of the leakage in the signal indication pipes. See ports 23 and 23^1, Fig. 5; 34 and 34^1, Fig. 6; 39, Fig. 16; and 39 and 39^1, Fig. 25. Without some method of providing against leakage the switch or signal could be gotten over the first time almost as quickly as though the pipes contained normal pressure, but we would have to wait until the pressure behind the equalizing pistons reached something over 70 lbs. before switch or signal could be moved again.

SIMPLICITY.

As will be seen from the foregoing explanation, there is no delicate or complicated mechanism to get out of order, and that the apparatus does not require delicate adjustment. Springs perform no important function. If thought advisable, those on the signal indication pins can be discarded and weighted levers substituted; but as they are made amply strong, are in full view, and can therefore be easily inspected, there is no reason why they should give rise to trouble. Absence of electric and hydraulic apparatus contributes largely to the simplicity of the system.

SAFETY.

The pressure must be increased or decreased suddenly, otherwise the equalizing piston will not be actuated. A reduction or increase of pressure caused by a leaky slide valve will not actuate these pistons. To demonstrate this, one of each of the slide valves was made to leak very badly, the leak being very much greater than if valve was permitted to run for years with-

out attention. In each instance the increase or reduction of pressure caused by such leaks failed to actuate the equalizing pistons.

Should the high pressure controlling pipe of a switch, or a switch indication, spring a leak, and the pumps or compressors be unable to maintain the pressure against such leak, the switch will not fly over, nor will a false indication be given, for in order to get switch over or to get an indication, a sudden increase of pressure must be had in the low pressure pipe. Should the controlling pipe of a signal spring a leak, and the pumps or compressors be unable to maintain pressure against such leak, the signal will go to danger. It will be remembered that it is necessary to increase the pressure in the signal indication pipe to get tappet unlocked so as to put lever in its normal position.

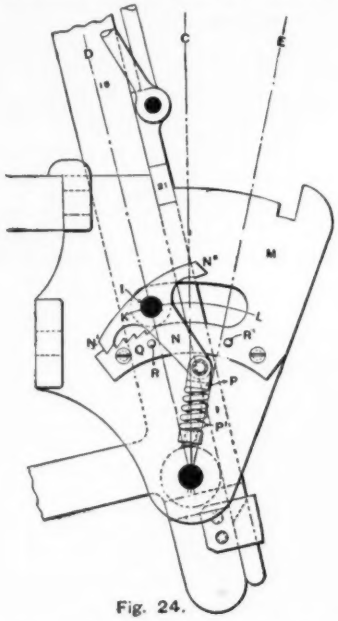
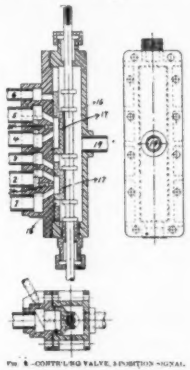


FIG. 24.—PAWL AND RATCHET ARRANGEMENT.

An experimental plant consisting of 8 levers, handling

2 Switches,
1 Cross-over, and
7 Signals, was put into operation Dec. 1st, 1894. Three-quarter inch gas pipe was used for controlling and indication pipes. No effort was made to protect the pipe lines, most of them being laid on the surface of the ground. With the thermometer at 10° below zero, no trouble was experienced with ice closing up the ports or passages, or causing the equalizing pistons to stick. A careful search was made, but not the slightest particle of ice could be found in any of the valves or passages. With the yard flooded with water to the tops of the ties, the switches and signals responded without interruption. Two 9½" Westinghouse pumps were used to compress the air for this plant. A ¼" cock



was left wide open on a pipe line of a signal 1,000 feet away, and even with this leak, the signal and its indication responded promptly.

Below is given the time consumed in operating the switches and signals, including indications for same, this record having been taken from the switches and signals comprising the experimental plant:

SWITCH.

100	feet away	0.8	seconds.
250	"	1.05	"
500	"	1.75	"
750	"	2.5	"
1,000	"	3.1	"

SIGNALS.

100	feet away	1.25	seconds	(high)
300	"	1.1	"	(dwarf)
350	"	1.34	"	(high)
500	"	1.91	"	"
1,000	"	3.07	"	"
1,500	"	4.00	"	"
2,000	"	5.56	"	"

It is not necessary to wait for pressure to equalize. By actual test, a switch was handled as follows:

250 feet away.....28 times per minute.
300 " .....20 " "

A signal was handled as follows:

300 feet away.....28 times per minute.
1,000 " .....20 " "

The Efficiency of Compressed Air Engines.

The increasing use which is being made of compressed air engines for mine and underground work stimulates the inquiry regarding their efficiency. By this is meant the percentage of power given out by the air engine bears to the power required to compress it.

The situation is apparently very simple. An engine drives an air compressor or compressing cylinder which forces air into a reservoir. The air under pressure is let through pipes to the various air engines, and is there used in the same manner as steam.

The resulting power is frequently a small portion of the power expended. In a large number of cases the fault is due to poor designing, and is not due to the fault of the system.

The losses are chargeable in a great many cases to fault of the compressor. This ordinarily is 15 per cent., but has been as low as 6 per cent., the average being about 12 per cent. in the common type of compressors; some of the high grade Corliss engines running air compressors will work on an average of less than 10 per cent. After the compressor we have the loss occasioned by pumping the air from the engine room, which would naturally be warm; therefore being lighter and less dense, this loss varies from 3 to 10 per cent.

Next the losses arising in the air cylinders. In sufficient supply, difficult discharge, defective cooling and a host of other things which perplex the designer and robs the owner of power. Next comes the loss in the pipes. This has, therefore, received by no means the consideration it should. The loss varies with every condition, and is somewhat perplexing. The next loss is due to fall of temperature in the cylinders of an engine, and often gives serious trouble. Losses often arise from leakage in pipes, and are too evident to call for much debate. No leak can be too small not to require prompt attention. The parties who are entrusted with the use of compressed air often permit loss which no engineering skill can prevent. We can only realize 100 per cent. efficiency in an air engine, leaving friction out of the question, when the changes of temperature are exactly the reverse in the air engine to those in air cylinder of the compressor, but these conditions can hardly be realized.

The air during compression becomes heated, and during expansion becomes cold. If the air immediately after compression and before losing any heat, could be expanded back to atmospheric pressure, it would on being exhausted have the same temperature as before, and consequently would exert as much power as it took to compress it (less friction).

But the loss of heat after compression and before being used again cannot be prevented.

We can by reheating with a very small amount of fuel expand the air and bring it up to nearly 100 per cent. efficiency. Consideration must be had for the friction of compressor and air engine.

We find for ordinary pressures, say 60 lbs., that the decrease in resistance to compression which is secured by the cooling attachment or improved circulating device, is equal to the friction of the compressor. Hence it is safe in calculating the efficiency of the air engine, to consider the compressor as working without cooling attachment and working without friction.

The result of such calculation would be too high for low pressures, and too low for high pressures. This of course is due to the fact that air at low pressure contains less heat than at high pressures.

Following is a table which gives nearly the correct efficiency of air under various pressures:

Gauge pressure—	2.9 lbs.	94.85	per	ct.	efficiency.
" "	14.7 "	81.5	"		"
" "	29.4 "	72.75	"		"
" "	44.1 "	67.00	"		"
" "	58.8 "	63.00	"		"
" "	73.5 "	56.75	"		"
" "	88.2 "	56.75	"		"

We observe the efficiencies of the lower pressure are much higher than that of the high pressure, and would be supposed to be most economical, but such is not the case, as air under a low pressure requires a much larger engine to do the work, and will therefore consume more air per H. P. than a smaller engine with higher pressure.

The matter of determining the efficiency of an air compressor varies so widely that it is impossible to lay down a rule to meet all conditions; hence we have to test every case separately, but ordinarily the efficiency of an air compressor can be taken at about 50 per cent.; under certain conditions it might be taken at 60 per cent.

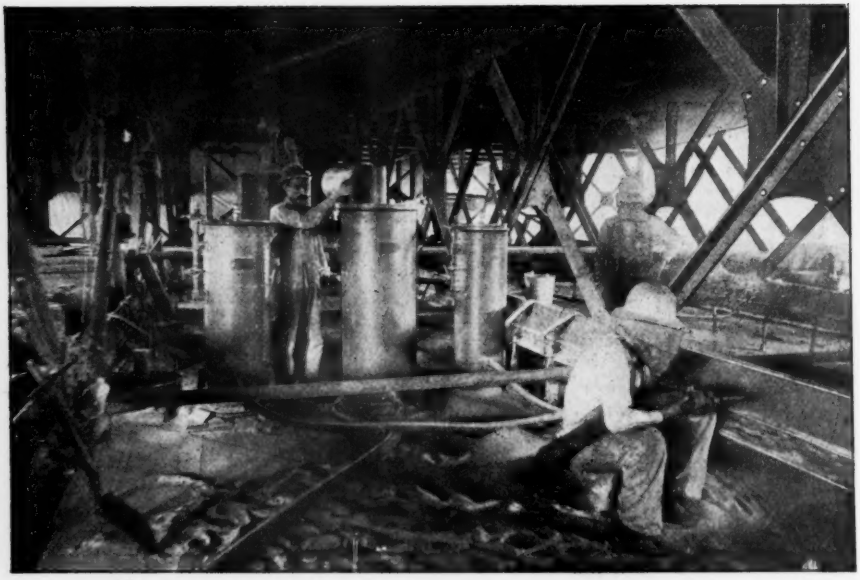
A. W. TUBBS

An Explosion in the Receiver of an Air Compressor.

The past occurrences of explosions in air compressors receive additional interest from the fact that an explosion has lately taken place in the receiver of an air compressor in Saxony, while one also occurred in the air compressing engines at the Clifton colliery, near Nottingham. The *Gluckauf* report gives the following as the probable cause of the explosion: In the valve-chest of the air cylinder, on the slide valves and on the inner surface of the compressed air pipes, a soot-like residue was found, the origin of which must evidently be referred to the employment of the lubricant; and this residue showed traces of coke formation, thus leading to the conclusion that ignition and combustion must have occurred. This view of the question is strengthened by the circumstances that the residue entered into partial combustion after the explosion, and that previous ignitions of the lubricant, owing to heating of the engine slide-valves, had been observed. The lubricant possesses, in common with other organic substances, the property of decomposing at high temperatures, forming gaseous products consisting of hydrocarbons with resinous residue. The incrustation on the valve-chest of the air cylinder and the compressed air pipes proves that such chemical changes took place owing to high temperatures. The gaseous constituents thus formed must have passed, with the compressed air, into the receiver, and have formed there, as well as in the pipes and valve-chests, a highly explosive gaseous mixture which, on being ignited, was capable of causing a very violent explosion. The action of such an explosion must have been so much the more intense as the gaseous mixture was subject to a pressure of nearly 4¾ atmospheres (70 lbs. per square inch) over that of the atmosphere; and this high pressure affords an explanation of the unusually violent mechanical action manifested.

As is evident from the above explanation, the explosion must have originated in the lubricant; and, owing to the great importance of the question, it appeared necessary to determine the composition and also the flashing point of the lubricant employed—which was done at the Royal Testing Station, Berlin. The tests showed the lubricant in question to be a good one and suitable for the purpose for which it was employed. The specific gravity was found to be 0.89 at a temperature of 15° Cent. (59° F.), while it was proved to be free from animal and vegetable fat and to consist of hydrocarbons which have taken up only a small quantity of oxygen. The ignition point, on the lubricant being heated in open crucibles, is near upon 291° Cent., the boiling point being 375° Cent. "This lubricant is, therefore," states the report, "entirely free from hydrocarbons of low boiling point, and consists of hydrocarbons differing so little from one another that great care must have been exercised in its production." If such an oil be allowed to drop into red-hot retorts it will become decomposed, like all other organic substances, and form gaseous products as well as more or less coke; and, by the evaporation of 20 grammes (2-3 oz.) of such an oil, about 1 cubic metre (35 cubic feet) of air may be rendered explosible. If now, notwithstanding this property of the lubricant, so considerable a fatty residue as that described was found in the valve-chests, this circumstance proves that, in consequence of the insufficient cooling down, and consequently great elevation of temperature, considerable quantities of the oil were gradually decomposed in the valve-chest; and this decomposition, with simultaneous formation of an explosive gas, was favored by the large surface of the valve-chest and the comparatively large quantity of oxygen drawn in. Consequently, the accident must be attributed primarily to insufficient cooling down of the valve-chests.

—Colliery Guardian.

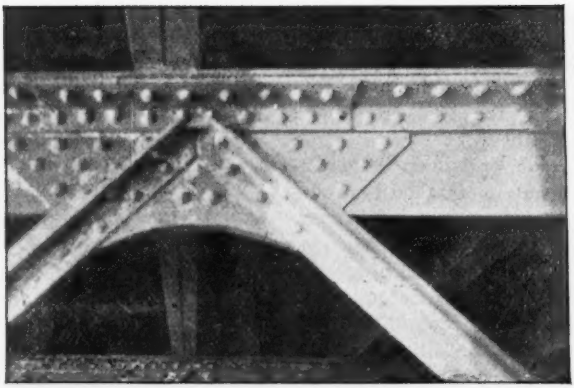


SAND BLAST IN OPERATION.

Cleaning Structural Iron by Sand Blast.

The city of New York is now trying the experiment of cleaning structural steel by the sand blast. The One Hundred and Fifty-fifth street viaduct is a steel structure and is used as a roadway with walks on each side. It suspends from Washington Heights across the Harlem River. At about the middle of the viaduct is the terminal of the Manhattan Elevated Railroad, and at this point there are almost continually one or more locomotives which throw out smoke and gases that ascend upward and radiate in the maze of trusses above. The effect of this has been to quickly destroy the paints that have been applied and to leave the surface of the metal exposed to the weather, and a consequent rapid deterioration from corrosion. Four coats of paint have been applied in five years and the necessity of doing something to protect the structure led to the experiment. The makers of the best paints are applying their best products side by side under equal conditions. The metal structure is cleaned in advance by the sand blast. The apparatus employed consists of two air compressors and a Ward and Nash improved Sand Blast apparatus of three mixers.

The free air delivered is nearly 400 cubic feet per minute, the pressure being maintained at about 20 pounds. The air is conveyed about 300 feet to an air receiver which stands near the sand mixing apparatus. The sand mixers are shown in the illustration. The sand is thrown in the hopper at the top and it finds its way down to the bottom of the mixer, where it meets the air, and the two commingled flow through a 1½″ rubber hose and is delivered through a cast iron nozzle with a hole 9-16 inch diameter. The sand and air pass through this tube at a velocity of over ten miles an hour. The operator holds the nozzle close to the surface to be cleaned and flying sand striking the scale and the paint which still adheres, loosens it and



SECTION OF STRUCTURE SHOWING SCALE AND CLEANED SURFACE.

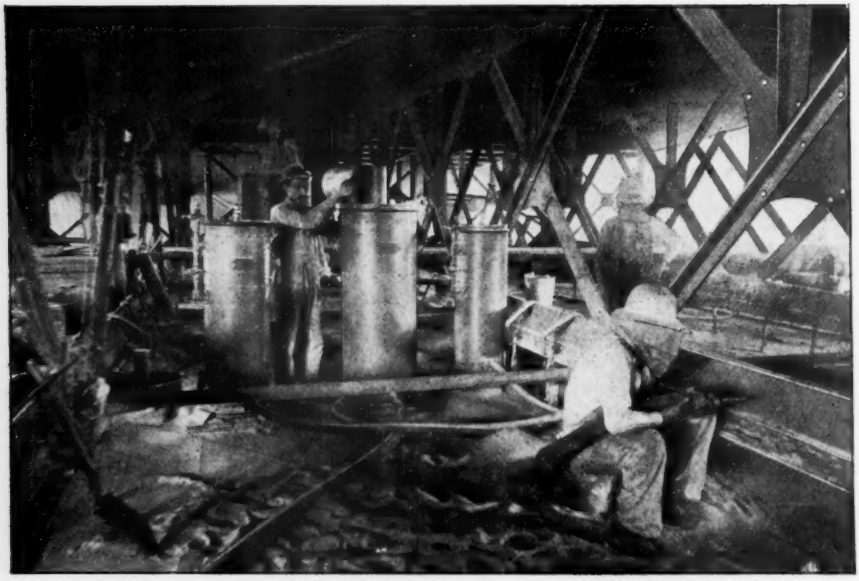
finally cuts it completely away, leaving the metal as innocent of covering as the moment it came from the foundry. It is absolutely and thoroughly cleaned. The metal now presents a perfect surface for painting, and painters begin work of painting every day at three o'clock in the afternoon, the earlier part of the day having been consumed by the cleaners. Two nozzles are kept at work at the viaduct. Combined, they are able to clean 700 to 800 square feet per day. There is a man for each nozzle, an engineer for the compressors and several men to carry sand and sweep and carry away refuse. Twelve tons of scale were taken off of the structure by means of a clean air blast before the sand was used.

It is assumed that this thorough and careful process of cleaning will so prepare the metal that the paint will now be firmly set when applied, and that it will fulfill its mission of preservation. The cost of cleaning by this method has not yet been determined, and fuller accounts of this will appear in future numbers.

A Remarkable Chip.

The illustration shows the reproduction of a chip taken from a piece of Steel by a No. 2 Boyer Pneumatic Hammer. It was taken off by a workman in Cramps shipbuilding yard at Philadelphia. The chip is 3′-9″ long, 5/8″ thick—width. It was removed at the rate of one foot every four minutes. One man with this hammer chipped as much in two minutes as two men did in six minutes. The hammer only weighs eight pounds. The piston has a 4½″ stroke and strikes 1800 strokes per minute. The Chicago Pneumatic Tool Co., makers of the above tool, has recently opened up a suite of offices in the Baird Building, 120-122 Liberty St., New York. At their rooms, 1005-1006, they will carry a full stock of tools and have them on exhibition working by air power in the office.

CHIP OF STEEL TAKEN OFF BY A BOYER PNEUMATIC HAMMER.

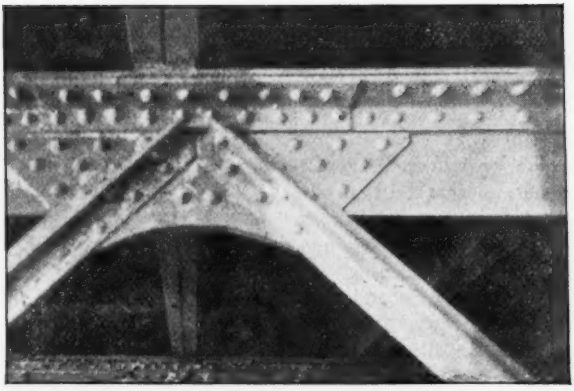


SAND BLAST IN OPERATION.

Cleaning Structural Iron by Sand Blast.

The city of New York is now trying the experiment of cleaning structural steel by the sand blast. The One Hundred and Fifty-fifth street viaduct is a steel structure and is used as a roadway with walks on each side. It suspends from Washington Heights across the Harlem River. At about the middle of the viaduct is the terminal of the Manhattan Elevated Railroad, and at this point there are almost continually one or more locomotives which throw out smoke and gases that ascend upward and radiate in the maze of trusses above. The effect of this has been to quickly destroy the paints that have been applied and to leave the surface of the metal exposed to the weather, and a consequent rapid deterioration from corrosion. Four coats of paint have been applied in five years and the necessity of doing something to protect the structure led to the experiment. The makers of the best paints are applying their best products side by side under equal conditions. The metal structure is cleaned in advance by the sand blast. The apparatus employed consists of two air compressors and a Ward and Nash improved Sand Blast apparatus of three mixers.

The free air delivered is nearly 400 cubic feet per minute, the pressure being maintained at about 20 pounds. The air is conveyed about 300 feet to an air receiver which stands near the sand mixing apparatus. The sand mixers are shown in the illustration. The sand is thrown in the hopper at the top and it finds its way down to the bottom of the mixer, where it meets the air, and the two commingled flow through a 1½″ rubber hose and is delivered through a cast iron nozzle with a hole 9-16 inch diameter. The sand and air pass through this tube at a velocity of over ten miles an hour. The operator holds the nozzle close to the surface to be cleaned and flying sand striking the scale and the paint which still adheres, loosens it and



SECTION OF STRUCTURE SHOWING SCALE AND CLEANED SURFACE.

finally cuts it completely away, leaving the metal as innocent of covering as the moment it came from the foundry. It is absolutely and thorougly cleaned. The metal now presents a perfect surface for painting, and painters begin work of painting every day at three o'clock in the afternoon, the earlier part of the day having been consumed by the cleaners. Two nozzles are kept at work at the viaduct. Combined, they are able to clean 700 to 800 square feet per day. There is a man for each nozzle, an engineer for the compressors and several men to carry sand and sweep and carry away refuse. Twelve tons of scale were taken off of the structure by means of a clean air blast before the sand was used.

It is assumed that this thorough and careful process of cleaning will so prepare the metal that the paint will now be firmly set when applied, and that it will fulfill its mission of preservation. The cost of cleaning by this method has not yet been determined, and fuller accounts of this will appear in future numbers.

A Remarkable Chip.

The illustration shows the reproduction of a chip taken from a piece of Steel by a No. 2 Boyer Pneumatic Hammer. It was taken off by a workman in Cramps shipbuilding yard at Philadelphia. The chip is 3′-9″ long, 5/8″ thick—width. It was removed at the rate of one foot every four minutes. One man with this hammer chipped as much in two minutes as two men did in six minutes. The hammer only weighs eight pounds. The piston has a 4½″ stroke and strikes 1800 strokes per minute. The Chicago Pneumatic Tool Co., makers of the above tool, has recently opened up a suite of offices in the Baird Building, 120-122 Liberty St., New York. At their rooms, 1005-1006, they will carry a full stock of tools and have them on exhibition working by air power in the office.

CHIP OF STEEL TAKEN OFF BY A BOYER PNEUMATIC HAMMER.

Pneumatic Despatch.

On Thursday, October 7th, the Tubular Dispatch .Co. gave a public demonstration of the Batcheller Pneumatic Dispatch Apparatus at the New York Post Office. Few appliances meet with a more auspicious reception or launch more genuinely into national importance than this one did. The Company's line is laid from the Post Office to the Produce Exchange. Among those present at the opening were Hon. Chauncey M. Depew, Second Asst. P. M. General Shallenberger, Ex. P. M. General Tyner, John E. Milholland and many others. At 12 o'clock Mr, Depew pulled the lever that sets the sending apparatus loaded with the carrier in place before the tube. Air pressure was automatically applied, and the carrier was projected on its journey. It went to the Exchange Building, which is 4,000 feet distant, and was returned. The trip took 4.35 minutes. The carrier is 24 inches long and 7 inches diameter.

It contained a variety of goods. The operation was repeated several times, each time carrying sundry articles. The table in front of Mr. Depew looked like that of a magician, whose exhibition brings forth beautiful and dazzling objects. Among the things carried were, a bible, a copy of the Constitution of the United States, a bunch of violets, an American flag, fruit, clothing, shoes, bric-a-brac, a bottle of wine, a live cat, etc., etc.

The air pressure necessary was 6 pounds. There is a receiving apparatus at the end of the tube that checks the speed of the carrier by means of an air cushion Then it is opened automatically and allows the carrier to emerge. It comes out upon a receiving table and strikes against buffers made of felt and other flexible material.

The demonstration was a success, and the hard work of the projectors of this system has terminated by a great triumph.

The system will probably be extended throughout New York City and Brooklyn. The work is now going on in Boston and Philadelphia and other large cities.

Liquid Air.

The subject of liquid air has of late attracted considerable attention, and in view of some erroneous statements which have become widely circulated, a few remarks in correction of such errors would seem timely.

Ordinary atmospheric air is nothing more or less than the super-heated vapor of a liquid, and the boiling point of air at about this liquid, is 312° F. This is probably the most reliable temperature of the boiling point of liquid air, being that obtained by Wroblewski, and quoted in Prof. DeVolson Wood's thermodynamics Much lower temperature can be obtained by evaporating liquid air in vacuum.

It should be noted that the boiling point of liquid air is lower than the boiling points of either of its principal constituents. Although some very creditable work of investigation in the subject of liquid air has been done in Europe by Dewar, Wroblewski, Olszewski, Pictet, Cailletet and others, comparatively little is defintely known of the chemical and physical properties and effects.

The physical effects of the low temperature of liquid air vary, but in general makes all substances very hard and brittle. While in the case of some metals the tensile strength is increased, the elasticity seems to have been destroyed. Heavy sheet iron becomes so brittle that it may be readily mapped in pieces with the fingers, and the fracture exhibits a finely crystaline structure. Gum rubber, meats, vegetables and other substances become hard and brittle enough to be broken in fragments by the hand. Ice, at this low temperature, crumbles into small pieces, and resin under slight pressure falls down in the form of a powder. Oils are readily solidified.

It would seem that some substances are brought almost to the point of disintegra-

tion, and the above examples are merely cited to give a slight idea of the various effects which this low temperature has upon the physical properties of matter.

Chemical affinity at this low temperature is apparently destroyed, and substances which combine violently at ordinary temperature have no effect upon each other in liquid air. From the laws of electricity we know that if a conductor were immersed in liquid air the low temperature would cause it to have practically no resistance.

It has been stated that the flesh, if immersed in liquid air long enough to come in contact with it, would be burned, the same as if it were exposed to a high temperature. This is erroneous, for while the nervous sensations are the same, the two effects are quite different, the high temperature producing a burn and the low temperature a freeze, which when produced by such a low temperature is much more painful than a burn.

It has been stated that "a handkerchief of silk, linen or cotton, saturated with liquid air, will be charred and destroyed just the same as if it were put in an oven and browned, though no change of color is apparent." This is also erroneous, as the fibre is merely frozen by the low temperature, and if allowed to remain undisturbed and return to the normal temperature again is not harmed in the least. But, if when in the frozen condition it is crumpled up and crushed, the fibre will be broken and destroyed. The statement that the vapor of liquid air when mixed with atmospheric air in certain proportions can be used for illuminating purposes seems to have been given considerable credence. The vapor of liquid air is nothing more or less than cool atmospheric air, and how two quantities of air mixed together will produce illuminating gas, is not plain to the writer.

In all the articles that have been written concerning liquid air, the work of Charles E. Tripler of New York, has been entirely ignored, and this is surprising, in view of the fact that he has devoted his entire time for the last twenty years to this line of investigation, and has brought the apparatus to a greater state of perfection than anyone else, and developed the subject to the point of commercial practicability.

During the past summer Mr. Tripler took a can of liquid air from New York to both Washington and Boston, starting with about four gallons in each instance. After being in transit eight or nine hours not over twenty-five per cent. was lost in either case.

The apparatus accredited to Prof. Linde and described in the August number of COMPRESSED AIR, is identical with an apparatus patented by Mr. Tripler five years ago. But, while with this apparatns of Prof. Linde's it takes five hours to obtain liquid, with Mr. Tripler's apparatus liquid air can be obtained in less than an hour from the time of starting. In a subsequent article the writer hopes to be able to give data concerning the properties of liquid air.

W. H. DICKERSON.

The Western Railway Equipment Company report that the Houston Sander has been adopted as standard by 75 railroads up to the present time, and they expect to add to that number five and ten more roads during the month of October. They claim for this device, on account of the small ½" delivery pipes (that the great velocity with which it delivers sand to the point of contact between the driver and rail), 50 per cent. more efficiency per sand used than any other device now upon the market, and claim also that it is by far the cheapest device to apply to old sand-boxes.

A catalogue of handsome design, excellent arrangement and proper proportions, has been received from C. H. Haeseler Co., Philadelphia, Pa., manufacturers of portable pneumatic tools. For any one in need of this class of appliances, a more comprehensive reference book could not be found. An accurate view of each machine is given as it appears when finished, then an actual photograph of a scene where the tool is at work. It is a good book to have at hand, and a good one to buy from. It can be had free on application.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz: all communications should be written on one side of the paper only: they should be short and to the point.

The Volumetric Efficiency of Air Compressors at High Altitudes.

It is well known that an air compressor will not deliver the same amount of compressed air at any given high altitude that it does at sea level. The percentage of delivery, or the volumetric efficiency of the compressor, is sometimes assumed to be the same for air compressed to any pressure. This is not, however, the case, and the supposition that it is may in some cases lead to serious consequences, especially if the compression of the air is considerable. Thus, the percentage of compressed air delivered at an elevation of 10,000 feet, at a gauge pressure of 30 lbs., is only 76 per cent. of what it would be at sea level; whilst if the air is compressed to 80 lbs. gauge pressure, the efficiency is only 71½ per cent. Therefore, assuming that an air compressor will deliver at sea level 100 cubic feet of air compressed to 30 lbs. gauge pressure, it will, with the same piston speed and nunber of strokes, deliver only 76 cubic feet of air, compressed to 30 lbs., at an elevation of 10,000 feet above the sea. The equivalent volume of free air is, however, the same in both cases.

Hence we see that the efficiency diminishes as the pressure to which the air is compressed increases, these differences of efficiency being, however, greater in proportion for the lower pressures than for the higher ones. The formula for calculating this efficiency is a very simple one, namely:

$$\text{Efficiency} = \frac{A}{G+A} \times \frac{G+14.72}{14.72}$$

where

A=Atmospheric pressure at any elevation,

G=Gauge pressure,

G+A=Absolute pressure at any elevation,

G+14.72=Absolute pressure at sea level.

The atmospheric pressure at any elevation is easily found by means of the following original but simple formula, which, it need not be said, is an empiric one:

$$\left.\begin{matrix}\text{Atmospheric pressure at any elevation} \\ = A\end{matrix}\right\} = 14.72 - \frac{57{,}000\,N - N^2}{100{,}000{,}000}$$

where

N=Elevation in feet at which the pressure A is sought.

This formula gives results in some cases varying about one-sixth of one per cent. from certain published tables, but it has the advantage that when plotted it gives a *perfect* curve, which no table that I have seen will do.

To find the volume of air compressed to any pressure, which is equivalent to a given volume of free air, at any elevation, we have the formula—

$$\left.\begin{matrix}\text{Volume comp'd} \\ \text{air}\end{matrix}\right\} = \text{Volume free air} \left(\frac{A}{G+A}\right)$$

A being, as before, the atmospheric pressure at the given elevation.

WILLIAM COX.

Editor "Compressed Air"

Can you or any of your readers inform me concerning a method of power production and transmission by means of compressed air, which uses the same air over and over again; at first compressing the air to some high pressure, then expanding to a portion only of the initial pressure, the exhaust being brought by a return pipe to the compressor and again compressed, and so on.

Is such machinery in operation anywhere, and by whom built or invented and presumably patented?

2 Wall Street.

New York, Oct. 4, '97.

PEN YAN, N. Y., Oct. 6, 1897.

Editor "Compressed Air":

I have been intensely interested in the paper "Liquid Air and Its Uses," and also in the account recently published in your

columns of experiment with air at high pressures.

I have done some experimental work with air at moderate pressures, but I am not one of the lucky few who can have the liquid article on tap.

Mr. Hiscox's admirable article gives us a great amount of valuable information, but still suggests a great many questions to be asked by a worker who sought to use *liquid air as condensed power*.

First, and probably most important, would be the question, would any development so far met with along this line indicate that natural laws make it possible or practical for us to realize returns in work for efforts expended in producing cold to any such extent as is done with the same amount of effort in producing heat?

Suppose, after having been able to produce or purchase a flask of liquid air I wish to realize upon my investment in work? Naturally one might suppose that if I inject homeopathic doses of it into a closed receiver it would endeavor therein to return to its original volume, and would exert a pressure in accordance with the space allowed it. Does it really accomplish this with sufficient rapidity to generate any considerable pressure? Or will its effort be exactly measured by its ability to absorb or extract heat from its surroundings? This last would seem to be inevitable, and the question will seem to have been unnecessary to those who have the opportunity for investigation. But I believe there are many readers who would like to know something about the action of liquid air in the process of re-conversion backward *under pressure* to the point where it is air again.

Very truly yours,

FRANK CAREY.

PNEUMATIC APPLIANCES.

PATENTS GRANTED SEPTEMBER, 1897.

Specially prepared for COMPRESSED AIR from the Patent Office files by Grafton L. McGill.

New York.

587,638.—Atr Pump. Horatio S. Bills, Ionia, Mich. Assignor to John H. Mitchell, same place.

The cylinder of the pump is provided with heads and inlet valves, one of the heads having a piston rod aperture. The piston rod is hollow and divided longitudinally into independent compartments by a partition, which latter is provided with an orifice. The piston also has orifices which open into the compartments of the piston rod. Located in the piston and leading to its opposite faces are ducts, the inner mouths of which are arranged to register with the orifices in the former. A spool-shape valve has its stem movably engaging the orifice in the partition, and is adapted to alternately close the orifices in the piston.

589,831.—Pneumatic Car Window. Wm. H. Heffley, St. Paul, Kan.

The piston of a cylinder is connected with the sash of a sliding window, the latter being of the usual construction. Passages controlled by a cock are located so as to form communication between the lower end of the cylinder, the source of controlling medium, and the atmosphere. A rod controls the cock, while a clutch dog designed to engage the piston rod is situated to be moved by said controlling rod. The window can be raised and lowered or held in any desired position by means of the rod.

590,153.—Automatic Pneumatic Railroad Switch. J. H. Johnson, Raleigh, and Neill A. McKeithen, Aberdeen, N. C. Administrator of D. J. McKeithen, deceased.

A switch-staff and connections between the staff and switch point are employed in connection with an air-compressing cylinder and a piston, an air-receiving cylinder being in communication, by means of a suitable pipe, with the compressing cylinder. Within said receiving cylinder is located a piston having a rod which controls the release of a locking device for the switch-staff. A piston located within the compressing cylinder is provided with parallel rods extending beyond the cylinder and provided with coil-springs. A connection from the switch-stand throws the switch-point, and other connections operate said piston. By means of the releasing mechanism the springs are permitted to retract the piston.

589,853.—Pneumatic Straw Stacker. L. D. Parmley, Waynesborough, Pa. Assignor of two-thirds to C. J. Danielson and M. D. Ellingston, Hamlet, Indiana.

A frame, carried by a discharge pipe, is provided with a revoluble, barrel-shaped cylinder, journaled therein. This cylinder is larger at its middle portions than at its ends and operates to deflect and spread the straw. The frame is also provided with means for raising and lowering the discharge pipe. In one side of the discharge casing is an opening with a lip at the bottom thereof. A hood, covering this opening, has an inlet in its lower part and an outlet above said inlet. A discharger, or fan, is journalled in the casing and provided with blades, having forwardly projecting lips on their front edges and rearwardly projecting lips of their rear edges, by means of which the air is forced spirally through the hole in the casing.

NEW YORK OFFICE:

122 LIBERTY STREET, ROOMS, 1005-1006, NEW YORK.

MANUFACTURERS OF

PNEUMATIC HAMMERS
PISTON AIR DRILLS
PNEUMATIC RIVETERS
CASTING CLEANERS
AIR HOISTS

All Machines guaranteed against repairs for one year.

Sent on 10 days trial subject to approval.

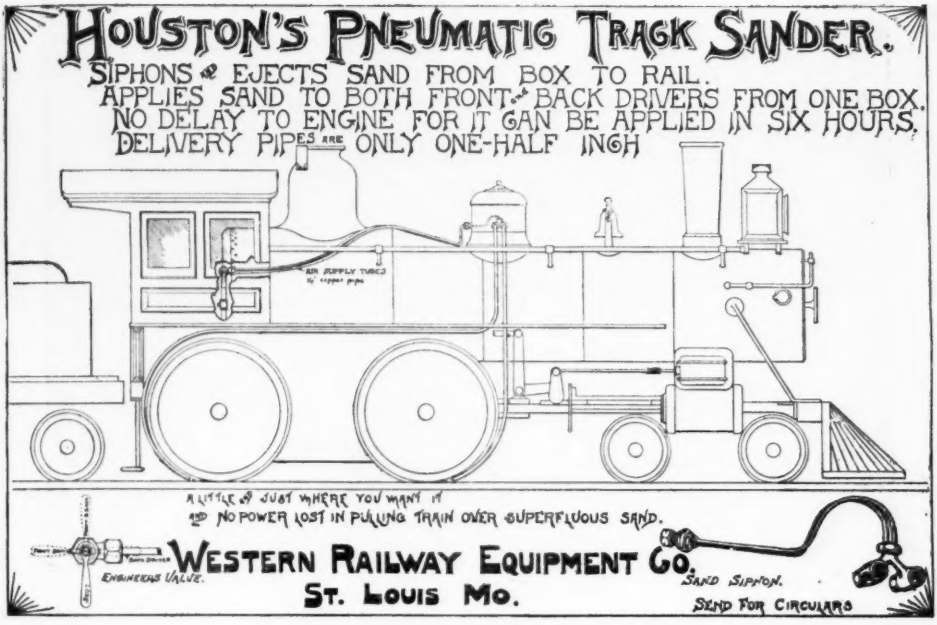
OVER 2,000 IN USE IN THE UNITED STATES.
OVER 800 IN EUROPE.

REFERENCES FURNISHED UPON REQUEST.

TRIAL ORDERS SOLICITED.

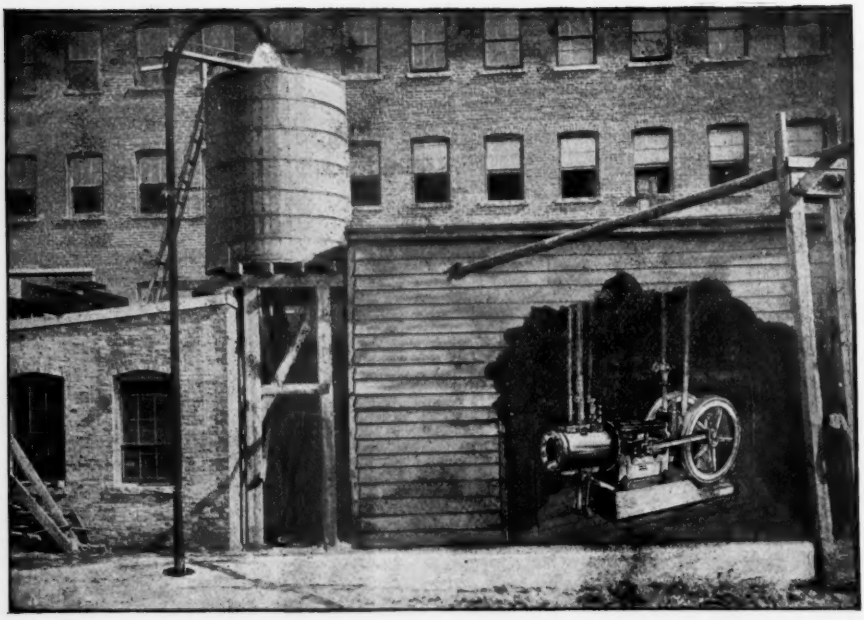
Chicago Pneumatic Tool Co.,

635 MONADNOCK BLOCK, - CHICAGO, ILL.


HOUSTON'S PNEUMATIC TRACK SANDER.
SIPHONS & EJECTS SAND FROM BOX TO RAIL.
APPLIES SAND TO BOTH FRONT & BACK DRIVERS FROM ONE BOX.
NO DELAY TO ENGINE FOR IT CAN BE APPLIED IN SIX HOURS.
DELIVERY PIPES ARE ONLY ONE-HALF INCH
AIR SUPPLY TUBES ½" COPPER PIPE
A LITTLE OF JUST WHERE YOU WANT IT
AND NO POWER LOST IN PULLING TRAIN OVER SUPERFLUOUS SAND.
ENGINEERS VALVE.
WESTERN RAILWAY EQUIPMENT CO.
ST. LOUIS MO.
SAND SIPHON.
SEND FOR CIRCULARS

TO those using compressed air in their works, it will probably be a matter of interest, to know, that we are now selling for (**$50**) **Fifty Dollars Net a Complete Whitewashing and Painting Machine,** for using one nozzle, of the same capacity, as those used in spraying **"Red Lead Paint"** on the Iron work of the New U. S. Appraiser's Stores in this City. As an item of information we will say, the entire expense for doing this work was less than would have been the cost of Brushes to do this same work! and the work is better done than could have been done by hand—for further information write to

TURNER MACHINE CO.,
35 W. 14th Street, New York.



POHLÉ AIR LIFT PUMP.

A view of one in operation at the Henry Lang Co.'s Leather Factory at Newark, N. J., pumping 10,000 gallons of water per hour.

SEND FOR CATALOGUE No. 73.

THE INGERSOLL-SERGEANT DRILL CO.,

PNEUMATIC DEPARTMENT,

HAVEMEYER BUILDING, - - - - NEW YORK.

Do You Roast Your Ores?

. . . . YOU CAN SAVE . . . .

FUEL, COST OF REPAIRS AND LABOR,

BY USING

The Ropp Straight Line Furnace,

FOR SALE BY

PARKE & LACY CO.,

21 & 23 Fremont Street, San Francisco, Cal.

SOLE LICENSEES. CATALOGUE UPON APPLICATION.

THE "NASON" AIR-HOIST

. . CYLINDERS . .

For use in conjunction with Compressed Air.

Made in sizes of from 2 in. to 8 in. inside diameter, with lift of hoist from two to ten feet.

CONTRACTORS FOR

The Installation of Pneumatic Hoisting Apparatus.

. . . SAFE, SIMPLE AND RELIABLE . . .

Correspondence Solicited.

NASON MANUFACTURING CO.,

71 BEEKMAN STREET, NEW YORK.

THE PULSOMETER STEAM PUMP

"The Contractor's Friend."

OFTEN IMITATED—NEVER EQUALED.
OVER 20,000 IN USE.

Recent Important Improvements.

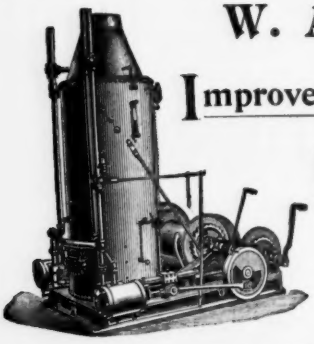
The Handiest, Simplest and Most Efficient Steam Pump for General Low Service Mining, Quarrying, Railroad, Irrigating, Drainage, Coal-washing, Tank-filling, Paper Mill, Sewer and Bridge Contractors' Purposes, etc., etc.

Muddy or gritty liquids handled without injury to the Pump.

PULSOMETER STEAM PUMP CO.

Catalogue on Application. **Correspondence Solicited.**

135 GREENWICH STREET, NEW YORK.



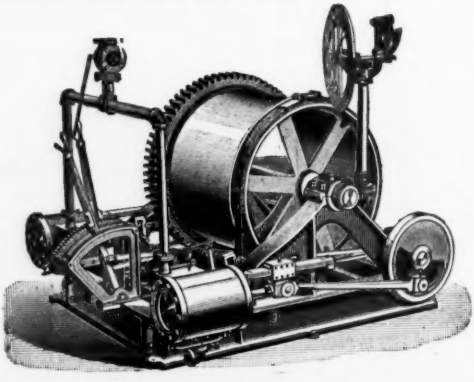
W. A. CROOK & BRO.'S CO.,

Manufacturers of

Improved Hoisting Engines,

FOR PILE DRIVING, RAILROADS, BRIDGE BUILDING, MINES, QUARRIES, COAL HOISTING AND BUILDING PURPOSES.

BUILT ON THE DUPLICATE PART SYSTEM.



OVER 350 SIZES AND STYLES.

Log Hauling by Steam and Suspension Cableways.

BOSTON OFFICE:
47 Pearl Street, cor. Franklin.

MAIN OFFICE AND FACTORY:
117-123 Poinier Street, Newark, N. J

SALESROOM:
143 Liberty Street, - New York.

— ON ADMIRALTY AND WAR OFFICE LISTS.—

THE MANNESMANN TUBE Co Ltd

LANDORE R.S.O. SOUTH WALES.

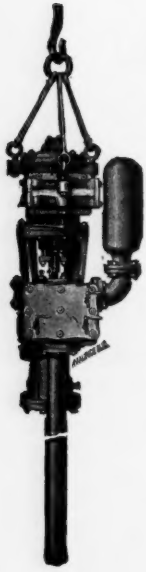
D. B. McILWAINE,

SOLE AGENT FOR AMERICA,

NEW YORK OFFICE:

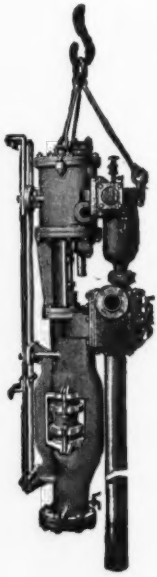
122 Chambers Street, New York.

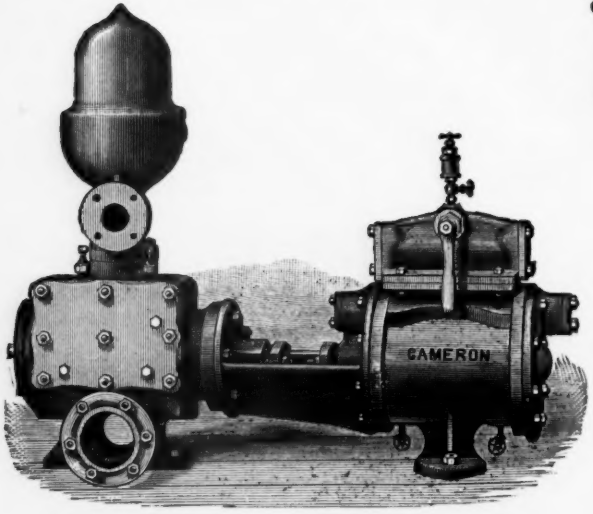
CAMERON STEAM PUMPS.



Simple,
Compact,
Durable,
Efficient.

NO OUTSIDE VALVE GEAR.





ADAPTED TO EVERY POSSIBLE DUTY.

MANUFACTURED BY

THE A. S. CAMERON STEAM PUMP WORKS,

Foot East 23d Street, New York.

ARTESIAN WELLS

RUST'S SYSTEM.

We have saved our Customers over

$5,000,000

In Water Bills.

Our System is Reliable, Economical and Satisfactory.

WRITE US FOR FULL PARTICULARS.

Rust Well Machinery Co., Ithaca, N Y.

THE ENGINEERING MAGAZINE

AN INDUSTRIAL REVIEW

The Engineering Magazine has been aptly described as "*The Century* of the industrial world and the *Review of Reviews* to engineering literature — the two in one." Its leading articles treat the subjects uppermost in importance in industrial affairs. Its contributors include the foremost men of our times. It gives each month an exhaustive Review and Index to the world-wide range of technical literature — American, English, French, and German. It is read in every nook and corner of the civilized world. It is founded upon the idea of meeting the requirements of the busy and brainy men who manage, think, and plan for the engineering, architectural, electrical, railroad, mining, and mechanical industries. It has a larger bona-fide circulation among such men than has ever been attained by an engineering journal in all the history of industrial literature. It is priceless to the active man who needs to keep in touch with current developments. Its every page carries a living interest for intelligent readers who are in any way concerned with modern industrial enterprises. Its subscribers are its warmest advocates and the Magazine itself is its best solicitor. *Sample copy free.*

30 Cents a Number] $3.00 a Year.

THE ENGINEERING MAGAZINE,

120-122 Liberty St., New-York, U. S. A.

Compressed Air.

Practical information upon Air-Compression and the Transmission and Application of Compressed Air.

By FRANK RICHARDS. 12mo, cloth, $1.50

John Wiley & Sons, New York.

HERTFORD C. CHAMP,

MECHANICAL AND ELECTRICAL **ENGINEER,**

Pneumatics, Hydraulics,

Generation and Distribution of Power.

CORRESPONDENCE INVITED.

322 East 15th Street, - - New York.

Patents, Trade Marks, Designs.

Searches as to Novelty; Reports on Infringements; Patent Matters Exclusively; 15 Years Experience.

Refers to Publishers this Magazine.

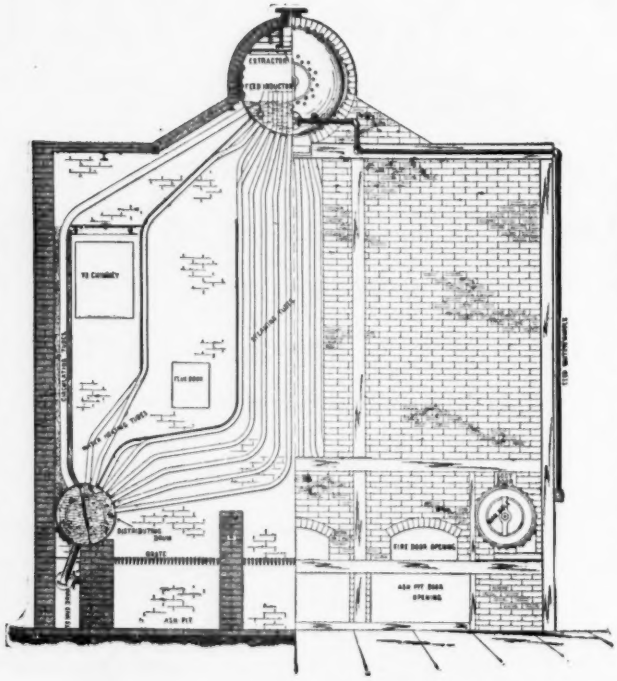
FRANKLAND JANNUS,

Attorney-at-Law, Atlantic Bld., Washington, D. C.

Always have Title Examined before Investing in Patent Property.

HOGAN WATER TUBE BOILERS

PERFECT IN DESIGN.



UNSURPASSED IN ECONOMY.

Always give entire satisfaction. Combines every desirable feature in boiler construction and design.

SAFE, EFFICIENT, DURABLE, FREE FROM SCALE on heating surfaces. Has POSITIVE and CONTINUOUS CIRCULATION. Need no feed water heaters or steam separators.

Delivers all steam above the water line.

The WATER LINE is STEADIER than can be found in ANY OTHER WATER TUBE BOILER.

. . . Manufactured by .

HOGAN BOILER COMPANY, MIDDLETOWN, N. Y.

☞STEAM AND AIR DRILL HOSE A SPECIALTY.

THE MANHATTAN RUBBER MF'G CO.

CABLE ADDRESS "MIALOGIA"
TELEPHONE, 2965 CORTLANDT.

Steam Packing,
Pump Valves,
Air Compressor Valves,
Rubber Belts,
Car Springs,
Gaskets,
Suction Hose,
Emery Wheels,

THE MANHATTAN RUBBER MFG. CO 64 CORTLANDT ST. N.Y.

FRANK CAZENOVE JONES,
PRES'T AND GEN'L M'G'R.

ALL KINDS OF MECHANICAL RUBBER GOODS.

Factories: Passaic, N. J. (on D. L. & W. R. R.)

General Office and Salesroom: 64 CORTLANDT ST., NEW YORK.

SEND FOR ILLUSTRATED CATALOGUE.

ELECTRIC BLASTING APPARATUS.

Adapted for All Kinds of Explosives used in Blasting.

VICTOR ELECTRIC PLATINUM FUSES.

Blasting Batteries

Leading and Connecting Wires.

Caps,
Fuse,
Etc.

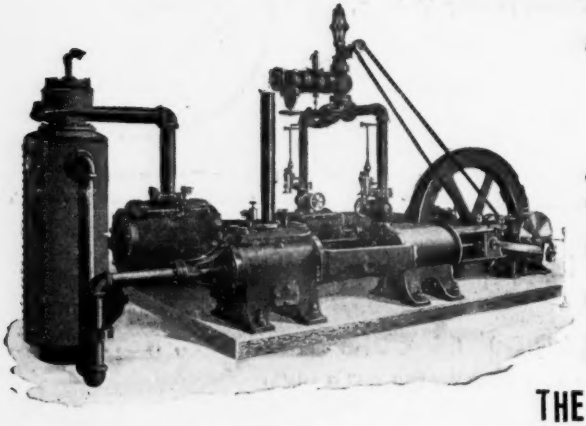
Manufactured Only by

JAMES MACBETH & CO.,

Send for Catalogue.

128 Maiden Lane, New York City.

COMPOUND Air Compressors



WITH COMPOUND AIR CYLINDERS AND RECEIVER-INTERCOOLER.

This design gives 10 to 15 per cent. increased efficiency over the common type of air cylinders.

ROCK DRILLS.

CHANNELERS.

COAL CUTTERS.

THE POHLE AIR LIFT PUMP.

THE INGERSOLL-SERGEANT DRILL CO.,

HAVEMEYER BUILDING, NEW YORK.

JUST ISSUED 9

Catalogue No.

CLAYTON

Air Compressors

And mailed FREE on application.

Special Air Compressors for all R.R. Car Shop Use.

CLAYTON AIR COMPRESSOR WORKS,

26 Cortlandt St., NEW YORK.